123. Outline of the Cambrian System in the Yangtze Basin, II.

*The Aspect of the Cambrian Faunas of the Basin and the Rock-Facies and the Thickness of the Cambrian Formation in the Basin.**

By Teiichi KOBAYASHI.

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The Aspect of the Cambrian Faunas:—In dealing with trilobites which are more important than most other fossils I have tried to figure out the broad outline of the Cambrian fauna of the Yangtze province. At the outset, it should be noted that the term " Hwangho basin " is used hereafter for the Cambrian basin in Eastern Asia on the north side of the Tsinling-Keijo line.

While nothing has been mentioned of the palaeogeographic bearing of Cambrian fossils in Central China except in the case of *Lopnorites*, Mansuy emphasized the intimate relationship of the North Chinese faunas with those which he described from Yunnan and Haut-Tonkin. His conclusion is correct insofar as the faunas in Kushan stage are concerned. In fact two-thirds of the species in the fauna are exactly identifiable with those of the Hwangho basin and the remainder belong to the genera known from the Kushan stage in the basin except *Annamitia spinifera* which is endemic to Yunnan and Tonkin. As to the other faunas however the relation is not so close as he considered, and in addition it must be noted that the faunal alliance to those on the west side of the region can be recognized though in a lessened degree. Furthermore there are several endemic genera and species, the localization being highest in the *Yunnanocephalus* fauna which, remarkably enough, comprises no genus known so far outside of this region.

It is well known that *Redlichia* in the Shoran stage is widely distributed from Eastern Asia to Iran in the west and Australia in the south, but *Palaeolenus* and *Sinolenus* in the upper part of the stage are unknown in neighbouring regions. The tendency to localize is strongest in the Misakian stage which contains *Yunnanocephalus*, *Wutingaspis* and *Palaeolenus* but the tendency becomes weak subsequently.

Tonkinella, *Bailiella* and *Hundwarella* are especially important among the early Changhian trilobites because the first genus is distributed from Kashmir to western North America through Chosen; the second is a typical Atlantic member but occurs in Asia from Kashmir to South Manchuria through Chosen. *Hundwarella* which is a subgenus of *Manchuriella* occurs in Kashmir in association with *Tonkinella* and *Bailiella* but is unknown in Eastern Asia. " *Ptycho-*

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paria" *defossa* Reed from a bed in Spiti which is presumably a correlative of some horizon in the early Changhian is, I think, a probable link between Misakian *Yunnanocephalus* and early Kushanian *Annamitia*.

Excepting the *Yunnanocephalus* zone all others contain one or more genera of trilobites which are known from the Hwangho province. But they are specifically distinct except certain Kushanian and Chaumitian species. As has been mentioned already, there are many species in the Kushan stage which are distributed on both sides of the Tsinling-Keijo line but none of the peculiar damesellids are known outside of Eastern and Southeastern Asia excepting *Ctenoseura eremita* in Sweden which bears similar aspects.

The *Billingsella*, *Prosaukia* and *Calvinella* beds, each contains only one which is identifiable with the northern species. The similarity in the general appearance can clearly be seen between these Yangtze and Hwangho faunas, but at the same time the fact can hardly be overlooked that similar faunas containing *Chuangia*, *Kaolishania* and *Iranaspis*, the last of which is a saukid, are known to exist in the far west in Iran. It is quite certain that the late Chaumitian Sea on the south and east sides of Asia was connected with the Franconia-Trempealeau of North America through the Yukon-Alaska boundary because there are several genera common to these regions. In regard to the Fouchoan faunas it should be noted that the Dorypygerinae and Dolichometopinae which are two important members on the north of the Tsingling line are not well represented on the south side. Finally, *Lopnorites* is a solitary trilobite showing the faunal connection of the Central Chinese fauna with the early Upper Cambrian of Tienshan in Central Asia.

Rock-facies and the thickness of the Cambrian Formation in the western part of Yangtze Basin:—

The Cambrian successions of the Omeishan district, Yangtze gorge, East Yunnan and Yunnan-Tonkin border presented in the preceding paper are the four good ones so far known in the basin. In the south in East Yunnan there is the Tsanglangpu series, in which calcareous rocks are exceedingly rare, in marked contract with the Mantoan formations in the Middle Yangtze Valley. There is a great difference in the calculation of its thickness given by Deprat and by Ting and Wang, but it is certainly not less than 200 metres thick. It is underlain by a sandstone formation of more than 300 metres in thickness without any distinct break. Therefore this formation must be Bunsanrian, if not Sinian. The thickness of the Cambrian system measures about 700 m in the Yangtze Gorge but becomes a little thinner in the Omeishan section in Szechuan. The Luchiapo sandstone in North Hupeh suggests an approach to land which must have been a part of the Tsinling-Keijo emerging axis. It is certainly a remarkable fact that archaeocyathid limestone is extensively distributed in the Middle Yangtze valley.

In the West Yunnan and the Shan plateau of Burma farther west the Ordovician is the oldest fossiliferous formation. Without any

considerable discordance it is underlain by a thick formation of variegated phyllite and qurtzite called Kaoliang (高梁) in Yunnan and Chuang Magyi in Burma where it is accompanied by rhyolite and its tuffs of Bawdwin. The Kaoliang is said to overlie the gneiss complex discordantly on the west side of the Lantsangkiang (瀾滄江).

In Yunnan-Tonkin border there is the Changpoung series the basal part of which is perhaps contemporaneous with the upper Tsanglangpu above the *Yunnanocephalus* beds. There is evidence which necessitates a great reduction in the thickness given by Deprat for the Changpoung. But even if the figure is reduced to a half, a thousand meters for the Fouchouan and Chaumitian series is considerably thicker than any of the two series known in other places in Eastern Asia. The frequent intercalations of sandstone and greywacke are characteristic of the series and suggest a plentiful supply of terrigenous material probably from the south side because in Southeastern Asia this is the southern limit of the Cambrian formation, if the so-called Cambrian formations in western Tonking and Cambrodga, whose ages have not yet been thoroughly determined, are disregarded. To the south of this boundary the Lower Ordovician Dongvan sandstone at Thanhoa is perhaps the oldest.

In Kwantung and Kwansi the Valentian graptolite shale of Lientan is the oldest fossil bed, if the ambiguous Ordovician fossils found at Litung in Yanghsien in SW Kwansi are left out of consideration.

A discussion on the Cambrian Stratigraphy in the Lower Yangtze Region :—

Little is known of the pre-Devonian stratigraphy of the Fukien massive, but as will be mentioned later there is evidence showing that the massive is overlain by a Cambrian formation on its northwest side. There is however a break in the records of the Cambrian fossils in the Lower Yangtze Valley. This defect in our knowledge allows one the liberty to refer the pre-Ordovician formations to either Cambrian or Sinian, giving rise to confusion in the Older Palaeozoic stratigraphy. Because the succession of the Cambrian formations of South Chosen in the eastern extension is immensely clarified, and because this standard succession shows a great similarity to that of the Lower Yangtze, my comments on the previous works are presented here.

In the Lower Yangtze Valley there is a good display of Ordovician graptolites shales. In South Anhui the upper one is called Hulo (胡樂) and the lower one Ningkuo (寧國) the latter of which is upper Arenigian. The Tanchiachiao (譚家橋) shale and mudstone formation lying beneath the Ningkuo 90 m. thick and containing *Birmanites*, *Asaphopsis* and *Clonograptus tenellus* var. *callavei* Lapworth, must be an approximate equivalent of the Bunkoku (文谷) formation inclusive of the Tomkol (斗務洞) shale in South Chosen. Beneath the Tangchiachiao there is the Hiuning (休寧) series over 600 metres thick. Because there is no break between them it is reasonable to consider the Hiuning as Cambrian, instead of Sinian as has been thought formerly. Furthermore in reading its description I was struck by its remarkable resemblance to the Cambrian succession of the Neietsu type in South Chosen.

The upper 300 to 400 metres of the series is composed of gray limestome " followed down by interbedded calcareous and carbonaceous shale and thin limestone (I). This is in turn followed by well-laminated siliceous rocks with alternating white and black layers each 2 or 3 cm. thick (II). The total thickness of these siliceous beds reaches 80 m. then follows a series of black limestone intercalated with black shales which are often highly carbonaceous (III)." Insofar as the description is concerned, the upper gray limestone (I) plus the middle siliceous beds (II) agrees well with the Gakoku (瓦谷) and the black limestone and shale (III) in the lower part with the Machari (磨磋里) formation in South Chosen. There is however some disagreement. Beneath the Machari comes the Samposan (三方山) green phyllitic beds in which I know of no conglomeratic shale fitting the description of Lantien tillite (?), but as it is only 5 to 10 m. thick it may be a local existence. The Pihyuan sandstone measuring 12,000 m. is four times thicker than the maximum thickness of the Sohsan (壯山) quartzite so far known, the former being green and purple but the latter generally white or gray. In other words the Samposan equivalent is much thicker here and the Samposan-Beiho (三方山, 猫峰) equivalent is represented by a thin layer of conglomeratic shale. Such differences in the basal part can however easily be expected between remote places. If these basal sandstones are admitted to be correlated with each other by this reason, the Shangchi formation lying discordantly below the Pihyuan must be the correlative of the Taihakusan (太白山) series below the Sohsan, lying also discordantly.

In Chekiang there is the Yinchoufu (印渚埠) series, some 400 m. thick, of which the shales in the upper part yield Lower Ordovician graptolites. The lower part consists of argillaceous limestone (I), impure limestone (II) and black slaty shale with luster (III) in descending order, the last of which is underlain by Taoshuiwu (倒水烏) series composed of coarse grained dark sandstone and conglomerate (III). Judging from the change of rock-facies it is quite reasonable to correlate the argillaceous limestone (I), impure limestone (II), black shale (III) and coarse sandstone together with conglomerate (IV) with the Kasetsu (花折) group Taiki (大基) limestone, Beiho slate and Sohsan quartzite in South Chosen respectively. It is a remarkable fact that the basal quartzitic sandstone overlies Chuchih metamorphic rocks unconformably, this relation being comparable to the superposition of the Sohsan quartzite on the Taihakusan series.

Black shales which are generally carbonaceous and less commonly calcareous appear to me to be one of the characteristics of these Cambrian formations. In the Nanking Hills the Huangshu series underlying the Lower Ordovician Lunshan (嵓山) limestone, also contains carbonaceous shale in the middle part. I think the same facies extends farther to the southwest in Hunnan because when I saw the specimen of *Lopnorites* from Lanhsi, it was indistinguishable from a certain rock member of the Machari formation.

Thus, there are several points of similarity between the Cambrian formations of South Chosen and those of the Lower Yangtze valley

notwithstanding the fact that the latter was thought to be either Cambro-Ordovician or Sinian. The type sections must however be re-examined before we can accept this suggestion that the two formations can be correlated.

Fossil List 1. Cambrian Biota of the Yangtze Basin exclusive of Trilobites.

Species \ Formation	Shoran	Misakian	Lower Changhian	Upper Changhian	Kushanian	Changshanian	Taishanian	Fengshanian
1. *Girvanella sinensis* Yabe	C_3							
2. *Coscinocyathus* cfr. *cancellatus* Bornemann	C_3							
3. *Cambrocyathus* cfr. *dissepimentalis* (Taylor)	C_3							
4. *Cambrocyathus sibiricus* (von Toll)	C_3							
5. *Cambrocyathus biseriatus* Chi	C_3							
6. *Archaeocyathus hupehensis* Chi	C_3							
7. *Retecyathus kusmini* Volodgin	C_3							
8. *Retecyathus laqeus* Vologdin	C_3							
9. *Retecyathus* cfr *camptophragma* Vologdin	C_3							
10. *Protopharetra* cfr. *densa* Bornemann	C_3							
11. *Obolus detritus* Walcott	S							
12. *Obolus damesi* Walcott			S					
13. *Obolus shansiensis* Walcott			C_5	S	S			
14. *Obolus* cfr. *chinensis* Walcott			S					
15. *Obolus* (*Westonia*) cfr. *blackwelderi* Walcott				S	S			
16. *Lingulella* cfr. *manchuriensis* Walcott				S				
17. *Lingulella* cfr. *marcia* Walcott				S				
18. *Obolella asiatica* Walcott			C_5					
19. *Obolella* cfr. *wirrialpensis* Etheridge	C_2							
20. *Dicellomus parvus* Walcott			C_5					
21. *Trematobolus* (?) sp.					S			
22. *Acrothele matthewi eryx* Walcott			S					
23. *Acrothelei lisani* Walcott				S				
24. *Acrotreta shantungensis* Walcott			C_5					
24. *Billingsella tonkinensis* Mansuy						S		
24. *Billingsella loungcoensis* Mansuy							S	
24. *Eoorthis agreste* Walcott					S			
24. *Eoorthis linnarssoni* Kayser						S		
24. *Eoorthis doris* Walcott								S
24. *Syntrophia orthia* Walcott						S		
24. *Huenella orientalis* Walcott						S		
25. *Helcionella "rugosa pauper"* Billings		(S)						
26. *Orthotheca glabra* Walcott		(S)						
27. *Orthotheca doris* Walcott			C_5					
28. *Orthotheca* cfr. *cyrene* Walcott				S				

Species \ Formation	Shoran	Misakian	Lower Changhian	Upper Changhian	Kushanian	Changshanian	Taishanian	Fengshanian
29. *Orthotheca* cfr. *cyrene dryas* Walcott								
30. *Biconulites* sp.	C_1							
31. *Bradoria douvillei* Mansuy	S							
32. *Aluta bergeroni* (Walcott)			C_5					
33. *Aluta enyo* (Walcott)			C_5					
34. *Aluta eris* (Walcott)			C_5					
35. *Aluta fragilis* (Walcott)			C_5					
36. *Aluta sterope* (Walcott)			C_5					
37. *Aluta woodi* (Walcott)			C_5					
37. *Aluta* sp.	S							
38. *Amiella prisca* Mansuy	S							
39. *Nothozoe* (?) sp.	S							

Fossil List 2. Cambrian Trilobites of the Yangtze Basin.

Species \ Formation	Shoran	Misakian	Lower Changhian	Upper Changhian	Kushanian	Changshanian	Taishanian	Fengshanian
1. "*Eodiscus*" sp.	C_2							
2. "*Microdiscus*" *orientalis* Walcott			C_6					
3. *Peronopsis* (?) sp.			S_4					
4. *Pseudagnostus* cfr. *douvillei* (Bergeron)					S_7			
5. *Redlichia verneaui* (Mansuy)	S_1C_2							
6. *Redlichia mansuyi* Endo and Resser	S_1C_2							
7. Irvingellid								
8. *Tonkinella flabelliformis* Mansuy			S					
9. *Kootenia* (?) *yüi* (Sun), nom. nud.	C_2							
10. *Menocephalites* sp.								
11. *Damesella brevicaudata* Walcott					S_7			
12. *Damesella paronai* (Airaghi)					S_7			
13. *Stephanocare richthofeni* Monke					S_7			
14. *Blackwelderia sinensis* (Bergeron)					S_7			
15. *Blackwelderia paronai* (Airaghi)					S_7			
16. *Parablaskwelderia spectabilis* (Endo & Resser)					S_7			
17. *Drepanura premesnili* Bergeron					S_7			
18. *Drepanura ketteleri* Monke					S_7			
19. *Kaolishania* spp.							S_9	
20. *Prochuangia* sp.						S_8		
21. *Chuangia nais* Walcott						S_8		
22. *Palaeolenus douvillei* Mansuy	S_2							

Species \ Formation	Shoran	Misakian	Lower Changhian	Upper Changhian	Kushanian	Changshanian	Taishanian	Fengshanian
23. *Palaeolenus lantenoisi* Mansuy	S_2							
24. *Palaeolenus deprati* Mansuy		S_3						
25. *Sinolenus trapezoidalis* Kobayashi	C_2							
26. *Wutingaspis tingi* Kobayashi		S_3						
27. *Wutingaspis conditus* Kobayashi	S_2							
28. *Yunnanocephalus yunnanensis* (Mansuy)		S_3						
29. *Yunnanocephalus yaoyingensis* Kobayashi		S_3						
30. *Annamitia spinifera* Mansuy					S_7			
31. *Hupehia pulchra* Kobayashi			C_5					
32. *Lorenzella tonkinensis* (Mansuy)					S_7			
33. *Koldinioidea orientalis* (Mansuy)								S_{10}
34. *Koldinioidea* (?) sp.								S_{10}
35. *Ptychoparia ligea* Walcott		C_4						
36. *Ptychoparia szechuanensis* Sun, nom. nud.		C_4						
37. *Lopnorites* cfr. *rectispicatus* Troedsson					C_7			
38. *Solenoparia* (?) *deprati* Kobayashi			S_4					
39. *Bailiella lantenoisi* (Mansuy)			S_5					
40. *Anomocarella* (s.l.) spp.			S_4	S_6		S_8		
41. *Manchuriella oblongata* (Mansuy)				S_6				
42. *Manchuriella latifrons* (Mansuy)				S_6				
43. *Manchuriella* sp.								
44. *M.* (*Hundwarella*) *termieri* (Mansuy)			S_8					
45. *M.* (*Hundwarella*) *tienfongensis* (Mansuy)			S_6					
46. *M.* (*Hundwarella*) sp.		S_5						
47. *Maladioides* (?) sp.							S_9	
48. *Eymekops sinensis* (Mansuy)		S_5						
49. *Eymekops* sp.		S_4						
50. *Lioparella propinquum* (Mansuy)		S_5						
51. *Haniwa* (?) sp.								S_{10}
52. *Shirakiella* sp.								S_{10}
53. *Dictyella* (?) *mansuyi* Kobayashi							S_9	
54 *Paracoosia mansuyi* Kobayashi					S_7			
55. *Paracoosia deprati* (Mansuy)					S_7			
56. *Prosaukia angulata* (Mansuy)							S_9	
57. *Saukiella* sp.								S_{10}
58. *Calvinella walcotti* (Mansuy)								S_{10}
59. *Omeishania yuhsienssuensis* Sun, nom. nud.		C_4						

See Table 1 in Part I for $S_{1\text{-}10}$ and $C_{1\text{-}7}$.